M20 DRO

Operation and Maintenance Manual

NEWALL

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This manual explains the operation of the M20 DRO. You should follow the basic steps systematically, and take care to ensure that you perform all procedures carefully.

The M20 measures the displacement precisely and accurately. To ensure the specified accuracies, you must install the M20 correctly and precisely.

You should read this manual carefully and thoroughly before using the product.

Main features

The M20 has the following features:

- Reset mode
- Set a value
- Abs/Inc mode
- Inch/mm mode
- Setting the Reference
- Rad/Dia mode
- Bolt hole pattern
- Angular bolt hole function
- 20 values SDM functions
- 4 tool offsets
- Calculator
- Selectable counting direction
- Floating negative sign
- Non-volatile memory
- Near zero warning
- Keyboard lock
- Fault signal indication
- Self diagnostic mode

Specifications

The M20 has the following specifications:

Mains supply	90...265VAC 50...60Hz
Fuse rating	T800' Slow-blow
Power consumption	20 Watts max.
Operating temperature	0°C to 45°C
Relative humidity	20% to 85% Non-condensing
Dimensions	267mm x 152mm x 82mm (L x H x D)
Net weight	1kg
Transducer input	5V TTL signal/Dedicated
Connector types	9 pin D (F) for transducer
Maximum count	± 10000.000 For 1 Micron ± 100000.00 For 10 Micron
Resolution	1/2/5/10/20/50 Micron
Display	± 7 digit (0.56 inch)
Quantization error	± 1 digit

Front panel

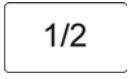
The M20 DRO has a user friendly keyboard, with positive-touch keys. The keyboard is a silicon type. The keyboard panel houses the common indications for all axes, namely INCH, MM, ABS, INC. A separate set of indications for diametric mode are provided for each axis (when indication is disabled it is in radial mode). The display consists of three rows of 7-segment LED displays. The rows indicate the X and Y axes. The display indicates a negative sign when the value is negative and blank if the value is positive.

Keys

X	Set the X axis Selects the X axis for the function
Y	Set the Y axis Selects the Y axis for the function.
0 to 9	Numeric keys
•	Decimal point numeric key
ENTER	To confirm entry
TOOLS	Invokes the tool offset function
C	Cancel entry key. Terminates the existing function or mode
REF	Stores count value as the Machine Reference and invokes the Home function
SDM	Invokes the SDM programming function
CALC	Invokes the calculator function
+/-	Selects the positive or negative sign when you enter values using the keyboard
PCD	Invokes the Bolt Hole function

Selects Absolute or Incremental mode

Selects Imperial or Metric mode



Invokes the half function

Invokes the Exit Sleep mode or DRO setting up mode

Numeric 4 / Left Arrow key

Numeric 6 / Right Arrow key

Numeric 8 / Up Arrow key

Numeric 2 / Down Arrow key

LCD indications

The following table explains what the LEDs mean when they are lit up.

INCH	Indicates that the DRO is counting in inches.
MM	Indicates that the DRO is counting in millimeters.
ABS	Indicates that the DRO is in Absolute mode, so it is counting the absolute travel from the set origin.
INC	Indicates that the DRO is in Incremental mode, so it is counting the incremental travel from the set point.
DIA	These LEDs indicate that the corresponding axis is using diametric counting. If these LEDs are off, then the corresponding axis is using radial counting.
LED	Blinks when the DRO is in Sleep mode.

General information

- Use the keypad to enter numeric values.
- Use the [**ENTER**] key to confirm your numeric entry and return to the previous display while saving the parameters.
- Use the [**C**] key to clear your numeric entries and return to the previous display without saving the parameters.
- When DRO is not in numeric entry, the [**8**], [**2**], [**4**] and [**6**] numeric keys work as [**UP**], [**DOWN**], [**LEFT**] and [**RIGHT**] arrow keys respectively.
- Use the [**UP**] and [**DOWN**] arrow keys to move between different fields.
- Use the [**LEFT**] and [**RIGHT**] arrow keys to toggle the parameters in a single field.

- Use the [+/-] key to change the sign of your numeric entry value at any time.
- The decimal point at the 7th digit and the INC LED on indicate that you are in Preset mode. In Preset mode the display indicates the distance to go to target.
- In this manual, [**name**] denotes a dedicated key name.

Setup mode (Engineering mode)

This chapter describes how to setup the M20.

You use this mode to set up the M20 to the required needs and specifications. You should not use this mode during the normal working and usage of the M20.

We recommend that you read the complete procedure for setting up the M20 before you implement the instructions.

The following sections describe each of the parameters and the procedure for setting them. In these instructions all the messages in quotes are actual displays on the selected axis.

Pressing the [**C**] key at any time suspends Engineering mode and shows the message "END". If you press the [**C**] key again, the DRO shows the message "SELECT". If you press the [**ENTER**] key, the DRO goes to normal counting mode.

Entering engineering mode

To enter Engineering mode to setup the parameters for using the DRO:

1. Turn on the DRO.
2. Press [**ON/OFF**] > [**ABS/INC**] > [**ON/OFF**].

In Engineering mode only authorized users can set or check the parameters. To accomplish this, there is a password facility (Software Lock). The Software Lock Code has already been set in the DRO Software. It is 123.

You can ask for the Software Lock facility to be disabled.

The following messages appear.

"ENTER" at the X-axis display position

"LOC” at the Y-axis display position

If you enter an invalid Lock Code:

You have three chances to enter the correct code.

If during these three chances, you enter the wrong loc code number initially on the X-axis, then the message "INVALID" is displayed in a blinking form for ½ second and you then see the following messages:

"TRY" at the X-axis display position

"AGAIN” at the Y-axis display position

You can then enter the code again.

If you have entered the code incorrectly three times, then the display shows "END" on the X-axis.

If you enter a valid Lock Code, the display shows "SELECT" on the X-axis.

This message indicates that you have entered the Engineering mode. This message also indicates the selection of an axis. There is no need to re-enter the Engineering mode to set another axis.

Selecting an axis allows you to enter the Engineering mode.

When you enter the Engineering mode, the display shows the previously set parameters. You set new parameters using the procedures given in the following sections.

*If you have entered Engineering mode to make one particular change e.g. "RAD" to "DIA", you must press the [**ENTER**] key to validate this change.*

Selecting the DRO mode

The M20 has two modes, Mill and Lathe. You should select the one that you require. Your selection affects the functions that are available

- Mill mode includes Bolt hole functions.
- Lathe Mode includes Tool offset functions.

In Mill mode, the [**TOOLS**] key has no function, and in Lathe mode the [**PCD**] key has no function.

To select the required mode:

1. Select [**X**] or [**Y**] to select the axis.
2. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
3. Press [**ENTER**] to select Mill or Lathe.

Setting the scale resolution

You can set the scale resolution to be 1.0, 2.0, 5.0, 10.0, 20.0 or 50.0 microns.

To set the scale resolution:

1. Select [**X**] or [**Y**] to select the axis.
2. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
3. Press [**ENTER**] to select the required resolution.

Setting the display resolution

The same options are available for the display resolution. The display resolution can never be lower than the scale resolution, if you set the display resolution to be less than the scale resolution, then it automatically changes it to the scale resolution.

To set the display resolution:

1. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
2. Press [**ENTER**] to select the required resolution.

While the display is showing displacement, you can select the least count with which the display is updated.

For example: If a reading is 5.456mm, then it displays as: 5.456 if the display resolution is 1 micron; and 4.5 if the display resolution is 10 microns.

Once you have selected the display resolution, the decimal point is set automatically.

Once you have selected the display resolution, the calibration factor is calculated and set. The DRO is calibrated for machine errors using the calibration factor (see for further information).

Setting the measurement units

You can select inch or mm. MM indicates metric measurement. This applies to all the axes. INCH indicates imperial measurement. This applies to all the axes.

To select the measurement units:

1. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
2. Press [**ENTER**] to select the required measurement units.

Once you have selected the measurement units, the DRO remains in this mode permanently and on-line conversion to the other measurement unit by pressing the [**INCH/MM**] key is disabled.

INCH MM indicates that on-line conversion to other measurement unit by pressing the [**INCH/MM**] key is enabled and the DRO can switch between INCH or MM mode. In this case, the measurement mode at power on is same as the mode at power off, e.g. if the DRO is turned off in INCH mode, at power on it will still be in INCH mode.

Setting the measurement mode

You can select RAD or DIA. RAD indicates radial measurement. Counts of the axis are shown in RAD only when you select this option. DIA indicates diametric measurement. Counts of the axis are shown in DIA only when you select this option.

To select the measurement units:

1. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
2. Press [**ENTER**] to select the required measurement units.

Once you have selected the measurement mode, the DRO remains in this mode permanently.

In this case measurement mode at power on is same as the mode at power off, e.g. if the DRO is turned off in DIA mode, at power on it will still be in DIA mode. This mode is selected in Engineering mode only.

Setting the counting direction

Here you select which direction of the slider movement will count as positive linear displacement. You can toggle between the left and right options by pressing [**LEFT**] and [**RIGHT**] arrow keys.

To select the counting direction:

1. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
2. Press [**ENTER**] to select the required counting direction.

Setting the calibration

The distance traveled by an encoder may differ from the actual travel. This error can occur due to machine wear and tear, misalignment of the scale, and other factors. This error can be linear or non-linear.

Calibration factor

DRO is calibrated for both, resolution of the transducer and machine error by a common factor called the calibration factor.

After traveling a known distance using a slip gauge, the DRO should display the value equal to length of slip gauge. The value counted by the DRO may differ from the actual distance if the DRO is not calibrated for scale resolution and machine error.

Machine error

There may be some degree of error or inaccuracy in the machine due to at least one of the following:

- Gravity causes deflection in machine tool structure.
- The fit between mating surface is loose.
- Driving or cutting forces cause deflection.
- Distortion of machine geometry due to temperature gradient.

These errors can cause inaccuracies in the readings of the DRO even though the scales and the DRO counter are accurate. Also, this error is different in different parts of the machine table.

You can compensate for a linear error in the DRO by multiplying the actual DRO actual readings by an error correction factor.

Calibration process

There is no need to delete the existing Calibration Factor, calibrating the DRO counter does that automatically and stores the new value.

1. Press the [**ENTER**] key when the DRO shows the message "DISPVAL".
2. Position the machine at a datum point.
3. Zero the axis being calibrated by pressing the [**X**], or [**Y**] key.
4. Move machine to the other end of slip gauge or measuring standard. Take no notice of the actual reading on the display.
5. Press the [**LEFT**] or [**RIGHT**] arrow key.
   The display shows '0'. Enter the slip value in Microns.
6. Press the [**ENTER**] key.
   “CALFAC" is displayed.

7. When you press the [**ENTER**] key again, the Calibration Factor is displayed. It is:

$$\text{Calibration Factor (microns/pulse)} = \frac{\text{Length of Slip gauge in microns}}{\text{Value counted by DRO}}$$

You can edit the Calibration Factor by pressing the [**LEFT**] and [**RIGHT**] arrow keys. You can edit it up to 6 digit decimal places. If you press the [**ENTER**] key, then you can bypass the editing stage.

You may need to edit the Calibration Factor to fine tune it, if small errors are found during production. If the counter display reads longer than it should, then you should reduce the value of the Calibration Factor. If it reads shorter then increase the value.

Setting the keyboard lock

During machining, if you accidently reset any one of the axes, then the current work piece may be damage. To avoid this, you can use the keyboard lock facility. There are two possible options:

LOC ON: If you select this mode in Engineering mode, then keyboard entry is disabled.

LOC OFF: If you select this mode in Engineering mode, then keyboard entry is enabled.

You cannot lock the keyboard for a single axis. Locking means that all the axes are locked simultaneously.

You can toggle these options by pressing the [**LEFT**] or [**RIGHT**] arrow key in Engineering mode.

To set the keyboard lock:

1. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
2. Press [**ENTER**] to select whether the keyboard lock is on or off.

Setting the beep status

BEEP ON: If you select this mode, then the Beep at keyboard entry is enabled.

BEEP OFF: If you select this mode, then the Beep at keyboard entry is disabled.

You can toggle these options by pressing the [**LEFT**] or [**RIGHT**] arrow key in Engineering mode.

To set the beep status:

1. Use the [**LEFT**] and [**RIGHT**] arrow keys to highlight the options.
2. Press [**ENTER**] to select whether the beep is on or off.

Saving the changes

In Engineering mode, when you change any single field, then when the "SAV CHG" message appears, you need to press the [**ENTER**] key, to save the changes permanently, otherwise the changes will be not be applied.

Factory default settings

You can revert to the following factory default settings for the currently selected axis, by pressing the [**ENTER**] key when the "RST DFT" message appears.

Parameter	Default Setting
DRO type	MILL
Scale Resolution	5 micron
Display Resolution	5 micron

Parameter	Default Setting
Measurement Unit	Inch / MM
Measurement Mode	Rad
Counting Direction	Left
Calibration Factor	1.0
Keyboard Lock	OFF
Beep	ON

When you have set all the paramters in Engineering mode, press the [**ENTER**] key to go to normal counting mode.

This chapter describes the M20's basic functions.

Reset function

During machining and setting operations, you often need to bring the origin to a particular point. With this feature you can redefine your origin at any desirable location. For example, to reference all relevant points on a work piece from a particular point such as the center of the work piece or a corner of the work piece.

To redefine your origin:

1. Select the axis that you want to reset.
2. Bring the tool to the reference point.
3. Enter 0.000 to reset the axis.
   This point is then used as the reference origin for all the relevant points on the work piece.

When the axis (X or Y) is in Linear mode, the display becomes:

0.000 (in MM mode)

0.0000 (in Inch mode)

Setting a new origin deletes the existing origin.

Setting a value

You use this feature to set any value (within range) to any position on the axis in Absolute mode. For example, to set a particular value to a corner or center of the work piece.

To set a value:

1. Bring the tool to desired point.
2. Select the X or Y axis.
3. Enter the value and press the [**ENTER**] key.

This new value is now shown for this position and a new origin is also set.

Setting a new value to a position deletes the existing origin.

Setting a new value to zero for all axes sets the new origin at the current position.

Once you have pressed the decimal point key you cannot enter an integer value.

Smart numeric entry

The position of decimal point depends upon the setting you selected for the Display Resolution parameter in Engineering mode.

For example, if you set the Display Resolution to 1.0 in Engineering mode, then if you enter the value 5678, the integral part changes to 5678000. However, if after 4 digits you do not press the decimal point key and you press another numeric key, say 9, the display changes to 6789000. If you keep pressing numeric keys, then the display keeps rolling over until you press the [**ENTER**] key or the decimal point key.

When you press the decimal point key, you can edit the fractional part of the value. Like the integral value this is also a rolling type entry until you press the [**ENTER**] key.

Abs/Inc mode

ABS is Absolute mode. Here the reference is taken from a common point when measuring a distance.

INC is Incremental mode. Here the reference is taken the first time that you press the [**ABS/INC**] key.

1. Power on the DRO.
2. Press the [**ABS/INC**] key.
   The Incremental value is set to zero.

This is now the incremental reference (datum) of the DRO.

If you reset the Absolute value, then the first time that you press the [**ABS/INC**] key after the reset, the incremental value is reset. This is now the new incremental reference of the DRO.

If in Incremental mode, you want to reset the incremental reference, for any axis you can press the particular axis key in Incremental mode. In this case the Absolute value remains unaltered and the incremental value is zero.

The feature toggles all the axes simultaneously.

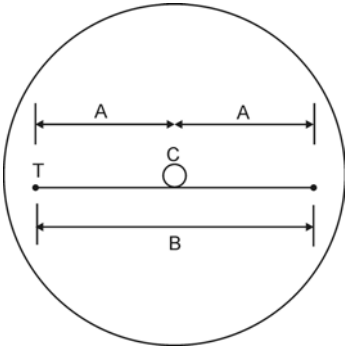
The incremental reference is a temporary reference. When you power off the DRO, this reference becomes zero.

Rad/Dia mode

You use this feature to display the measurement value in the required measurement mode, i.e. Radial or Diametric. It is particularly useful for lathe cross axis.

You select the required mode in the engineering parameter setting. In this mode you can toggle the display between unit value display and double value display for the selected axis. A corresponding LED indication is given near the front panel display for the respective axis.

The diagram below shows a cylindrical work piece with centre C. If the DRO is reset at C and T indicates the tool position, then A is the displayed distance in Radial mode. In Diametric mode, with the same tool position the displayed distance would be equal to B which is twice that of A.



Inch/MM mode

You use this function to convert a display value from metric to imperial units of measurement. It toggles between the two modes for all the axes simultaneously. The corresponding LED indication is given near the front panel display. In Inch mode, the decimal point is moved one position to the left.You can also use this feature to avoid complicated calculation of conversion of units during setting and machining operations.

To change between units, press the [**INCH/MM**] key.

You can only toggle between the two options if you selected Inch MM for the X axis in Engineering mode. Otherwise it remains as either Inch or mm.

Example:

If the counter is in MM mode (MM LED is lit), with the display showing 25.400, when you press the [**INCH/MM**] key, the display changes to 1.0000, which is the equivalent measurement in inches.The Inch LED is then lit.

1/2 function

You use this function to directly halve the current value on the axis. You can use this function to find the centre of the job.

1. Press the [**1/2**] key.
   You are prompted by the message “SELECT".
2. Select the desired axis whose value needs to be halved by pressing the [**X**] or [**Y**] key on the front panel.
   The value displayed on the desired axis is halved.

Executing the 1/2 function alters the origin of the axis.

Setting the reference

Referencing

The DRO has a built in feature to save the last reading at power off and restore the same reading at power on. It is possible that the slide may have moved while DRO is powered off. Hence the last reading stored by the DRO may not indicate the true position of the slide, so you need to reference the DRO to the Datum.

With the M20 you can set a reference for machining or settings at predefined locations on a selected axis. These predefined points are called ABS references or pulses and they are marked on the scale or transducer. They are encountered by the DRO when it moves along the slide. However, this can only be used when the referencing function is enabled. There are two methods for referencing: Home Function mode and Machine Reference mode.

In the Home Function mode, the display is set to 0.000 when the DRO senses the first Reference/ABS pulse.

In the Machine Reference mode, you can set the display to any predefined value after the DRO senses the first Reference/ABS pulse.

You move the slide to sense the ABS pulse. All relevant points on work piece are then referenced from this ABS pulse position.

Home function

The reference marks (ABS pulses) are located throughout the length of the scale or transducer. You can always select any one ABS pulse as the reference. The Home Function sets the display to 0.000 on encountering the first ABS pulse. Thus, you can permanently set a point on the machine table to be the origin. This is useful in batch production.

The DRO can sense the ABS/Reference pulse in both the directions. However, for repeat accuracies, you must ensure that you only sense it in one.

You should always sense the same ABS/Reference mark on the transducer that the DRO sensed the first time because the job dimensions are referenced to this mark.

Setting the Home Function

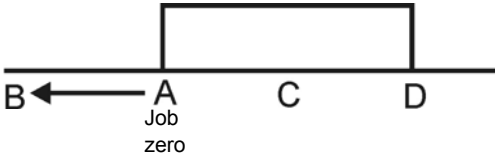
1. Press the [**REF**] key.
2. Select “HOME”.
3. Select the required axis.
   The last digit on the selected axis starts blinking.
   The DRO is waiting for an "ABS" pulse input from the transducer.
4. Move the (transducer) slide to sense the ABS pulse.
   The "ABS" pulse is sensed.

The DRO changes to normal counting mode with the zero position set at the ABS position.

Machine reference function

This function is analogous to the Home function, except that at the Reference Mark on the transducer, the Home function sets the display to zero, while Machine Reference function inserts the value that you saved as the Machine Reference.

The Machine Reference value is the distance of thet Job Zero from the Home Zero (i.e. the ABS mark on the transducer). The following diagram shows how to find and store the Machine Reference.



If the tool is at position C, then A-D is the job length and B is the nearest point outside the job at which transducer gives an ABS pulse. In this case, setting the machine reference makes the count zero at A.

1. Move the slide (i.e. the tool) near to position A; preferably between A and B.
2. Execute the Home function (see Home function on page 3-3) and move the slide towards B, as indicated by the arrow.
3. As the ABS pulse is encountered at B, the display shows zero.
4. Move the slide to A.
   The displayed value is the distance between the job edge and its nearest ABS pulse. At A, the counter shows a value (say 11.875). This is the machine reference value.
5. Now follow the procedure for storing the Machine Reference value (see Setting the machine reference value on page 3-4).

You have now successfully saved the machine reference figure and the current tool position of the axis, i.e. A, is marked as the Job Zero, A becomes the new origin.

Setting the machine reference

You can set the Machine Reference value on the axis as and when required, to establish the Job Zero.

1. Execute the setting machine reference function and move the slide towards B.
2. As the ABS pulse is sensed at B, the DRO restarts counting from the machine reference value stored earlier with sign reverse (i.e. -11.875). This is the distance of the Home Zero from the Job Zero.
3. In the example shown on page 3-4, if the slide is moved to A, then the display shows zero as desired, as A is the Job Zero.

The DRO can sense the ABS/Reference pulse in both the directions. However, for repeat accuracies, you must ensure that you only sense it in one.

You should always sense the same ABS/Reference mark on the transducer that the DRO sensed the first time because the job dimensions are referenced to this mark.

Setting the machine reference value

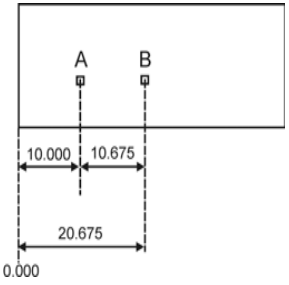
1. Press the [**REF**] key.
2. Select “HOME” > “MAC REF” > “SET MC”.
3. Select the axis where you want to store the value for the Machine Reference.
4. Enter 0.000.
   The value is stored, and the current value becomes zero, as this is the Job Zero position.

*Use the [**LEFT**] and [**RIGHT**] arrow keys to change the parameters in the field.*

Recall or execute the Machine Reference

1. Press the [**REF**] key.
2. Select “HOME” > “MAC REF” > “SET MC”.
3. Select the axis for which you want the Machine Reference to be performed.
   The last digit displayed on that axis starts to blink.
   The DRO is waiting for an ABS pulse input from the scale.
4. Move the slide to sense an ABS pulse.
   After receiving an ABS input from the scale, the DRO inverts the current stored value of Machine Reference and shows it on the display. Thus the Job Zero is achieved.
5. The DRO returns to normal counting mode.

*Use the [**LEFT**] and [**RIGHT**] arrow keys to change the parameters in the field.*



Preset mode

You use Preset mode to travel a predetermined distance on the selected axis. It is generally more convenient to locate the zero position on the display rather than reaching a complex figure (such as say, 10.675) by moving the slide. You can do this with the Preset mode, by making the destination point zero.

This chapter describes the M20's special functions.

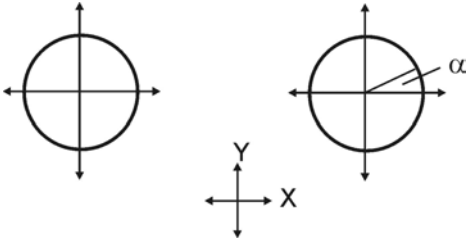
Circular bolt hole function

You use this function to create a table of coordinates of holes on the perimeter of a circle. You enter the geometrical data from the drawing: circle centre coordinates, starting angle, radius and number of holes to drill. The DRO automatically generates the required coordinates for each hole. The DRO shows the distance between the current tool position and the hole. To achieve the desired hole position, move the slide so that the DRO down counts to zero.

Parameters to be entered for a bolt hole:

ENTCNT 0	X coordinate of the centre.
ENTCNT 1	Y coordinates of the centre.
Radius	Radius of the circle.
Angle (a)	Starting angle for first hole.
Holes	No. of holes. max 10

In the following diagram, for the circle on the left the starting hole lies on the X axis, so you must enter the angle as 0.000. For the circle on the right, the desired holes are shifted by same angle with respect to the X axis, so you must enter the the offset angle, α.



*If you enter a number greater than 10 for the number of holes, then the message "invalid" is shown. You must then press the [**C**] key.*

It is assumed that holes are equally spaced on the circle.

To set up a bolt hole:

1. Press the [**PCD**] key.
2. Select "B HOLE".
3. Press the [**ENTER**] key.
4. Enter the X coordinate for the centre of the circle.
5. Enter the Y coordinate for the centre of the circle.
6. Enter the radius of the circle.
7. Enter the starting angle for the first hole.
8. Enter the number of holes (maximum 10).

As the machine works the holes the display shows the number of the hole that the machine is drilling and the distance to the next hole. When the job is complete, the display shows the coordinates of the first hole.

*You can press the [**C**] key at any time to bring the DRO back to normal counting mode.*

Angular bolt hole function

You use this function to create a table of coordinates of holes on an arc, i.e. part of a circle rather than a full circle. You enter the geometrical data from the drawing: circle centre coordinates, starting angle, ending angle, radius and number of holes to drill. The DRO automatically generates the required coordinates for each hole. The DRO shows the distance between the current tool position and the hole. To achieve the desired hole position, move the slide so that the DRO down counts to zero.

*If you enter a number greater than 10 for the number of holes, then the message "invalid" is shown. You must then press the [**C**] key.*

It is assumed that holes are equally spaced on the circle.

To set up an angular bolt hole:

1. Press the [**PCD**] key.
2. Select ""ANGHOLE".
3. Press the [**ENTER**] key.
4. Enter the X coordinate for the centre of the circle.
5. Enter the Y coordinate for the centre of the circle.
6. Enter the radius of the circle.
7. Enter the starting angle for the first hole.
8. Enter the ending angle for the last hole.
9. Enter the number of holes (maximum 10).

As the machine works the holes the display shows the number of the hole that the machine is drilling and the distance to the next hole. When the job is complete, the display shows the coordinates of the first hole.

*You can press the [**C**] key at any time to bring the DRO back to normal counting mode.*

SDM function

The SDM function is mainly applicable for mass production. In this function, you store the coordinates of different tool positions on machine permanently in the memory. You can then recall these stored coordinates for doing the same type of job.

Programming the positions

There are two ways by which you can program the SDM values: Program and Learn.

Program

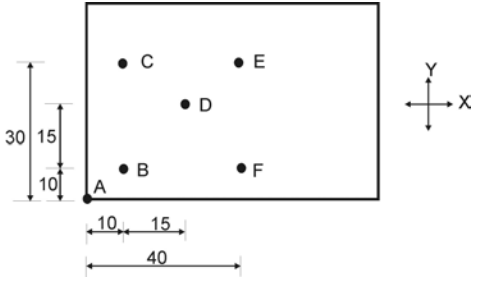
In this mode, you manually enter the coordinates of the position using the numeric keyboard. If the DRO is in ABS mode, then the value that you enter is considered as an Absolute value from the zero position. If the DRO is in INC mode, the value that you enter is considered as an incremental distance from the previous SDM value.

To program SDM values:

1. Press the [**SDM**] key.
2. Select 'PROGRAM'.
3. Press the [**ENTER**] key.
4. Enter the step number.
5. Enter the coordinates for that point.
6. Press the [**RIGHT**] arrow key to go to the next step.
7. Enter the coordinates for that point.
8. Repeat steps 6 and 7 until you have entered all the SDM values.

Example

The following diagram shows an example.



In the above diagram A, B, C, D, E and F are the points to be drilled. You would program these as follows:

SDM NO.		ABS Programming		INC Programming	
No.	Name	X	Y	X	Y
1	A	ABS 0.000	ABS 0.000	ABS 0.000	ABS 0.000
2	B	ABS 10.000	ABS 10.000	INC 10.000	INC 10.000
3	C	ABS 10.000	ABS 30.000	INC 0.000	INC 20.000
4	D	ABS 25.000	ABS 25.000	INC 15.000	INC - 5.000
5	E	ABS 40.000	ABS 30.000	INC 15.000	INC 5.000
6	F	ABS 40.000	ABS 10.000	INC 0.000	INC -20.000

You can program up to 20 SDM values in this way.

Learn

In this mode you don't use the numeric keypad for programming the SDM values. Instead the current tool position is considered as the SDM value. This mode is advantageous for large programs.

Using the same example as Program mode, you program the points as follows:

1. Reset the X and Y axes at point A.
2. Bring the tool to point B.
3. Ensure that Absolute mode is ON.
   The display shows:
   X: 10.000 Y: 10.000
4. Press the [**ENTER**] key to store the value.
5. Bring the tool to point C.
   The display shows:
   X: 10.000 Y: 30.000
6. Press the [**ENTER**] key to store the value.

You can program up to 20 SDM values in this way.

Run

You use the Run option to recall the stored SDM values to run the same type of Job.

Example

1. Press the [SDM] key.
2. Select 'RUN'.
3. Press 1 to recall SDM no.1.
   The display shows the distance from the current tool position to the

programmed SDM position. The second decimal point at the seventh digit indicates that the DRO is in Preset mode.

4. Move the tool to make displays zero.
   The tool has reached the position of SDM 1.

You can recall all the SDMs using this procedure.

You must ensure that the zero position for all the axes, while programming and recalling is the same. We recommend that the zero position is the Home Zero position, since it is easily found.

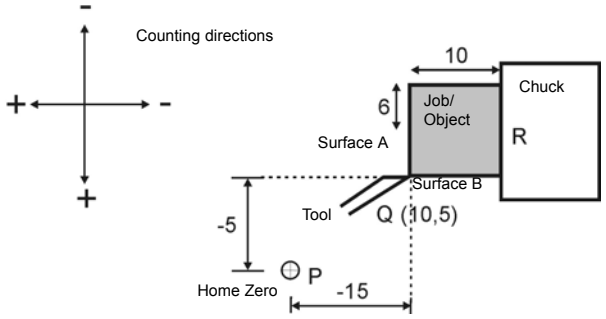
You can program a maximum of 20 SDM values.

SDM no.1 is always absolute.

*If you enter an SDM step number greater than 20, then the display shows the message "invalid". You must press the [**C**] key to clear this.*

Tool offset function

An example of this function is shown in the following diagram.



Point P is the Home Zero position on the machine. At point Q, tool no.1 shows readings as (-15, -5). At the same point Q, tool no.2 does not show the same reading because of the offset of the cutting edge of the second tool with respect to the first tool. With the tool offset function you can make the DRO display the same values when the cutting edges of different tools touch the same point on a work piece.

Entering tool offset values

1. Execute the Home function for both axes and establish the Home Zero position.
2. Touch the tool to surface A of the job.
3. Select the tool offset function and enter the value for the X axis (10.000 in the example shown above).
4. Press the [**C**] key to return to Normal counting mode.
5. Touch the tool to surface B of the job.
6. Select the tool offset function and enter the required value for the Y axis (5.000 in the example shown above).
7. Press the [**C**] key.

You can repeat the sequence from step 2 for all tools and enter the required values.

Implementing the tool offset

Using the example, the DRO calculates the actual offsets for different tools as follows:

At point Q, the DRO shows the reading as (-15, -5). The desired reading at point Q is (10, 5).

This means that the actual offset values are:

X: 10 - (-15) = 25

Y: 5 - (-5) = 10

At point R the normal DRO reading is (-25, -10), but because of the offset values, the DRO shows it as (0, 0) once you have implemented the tool offset.

The DRO calculates the actual offset values for all tools, as described above.

To implement the tool offset:

1. Press the [**TOOLS**] key.
   The display shows the current reading plus the actual tool offset.
2. Use the [**UP**] and [**DOWN**] arrow keys to find the tool that you want.
3. Enter the tool number that you want to implement.
4. Press the [**ENTER**] key.

*You can press the [**C**] key at any time to return to normal counting mode.*

Notes and cautions

You must ensure that the Home Zero position is the same, while editing and implementing.

The values that you can enter are dependent on the counting direction. For the shown example, if the counting directions are reversed, the desired value at point Q must be entered as (-10, -5), to make point R (0, 0).

You can program up to 4 tools. If you enter a tool no. greater than 4 then the message "invalid" is shown. You must press the [**C**] key to clear this. If you are scrolling through the tool numbers with the [**LEFT**] and [**RIGHT**] arrow keys, then after 4 the number rolls back to 1.

You must ensure that parameters such as RAD/DIA, INCH/MM and CAL.FAC are the same, while programming and recalling.

Calculator function

You use this feature to perform the following calculator operations. This means that you can perform simple on-line calculations while machining.

- Add
- Subtract
- Multiply
- Divide
- Sine
- Cosine
- Tangent
- Sine Inverse
- Cosine Inverse
- Tangent Inverse

Display and key modes

The X axis displays the number that you entered and the calculated result.

The Y axis is where you select the mathematical function to be performed.

Press the [**ENTER**] key to calculate the result of the current sum.

Press the [**C**] key to delete an entered number back to '0' if you have not pressed the [**Y**] axis key.

You use the number keys [0…9] to enter values.

*The [**+/-**] key is yet to be implemented.*

*The [**.**] (decimal point) key is yet to be implemented.*

Operation

The basic operation is the same as a typical simple personal calculator. The X axis represents the display of the calculator. As the DRO does not have keys available for the mathematical operators these are expressed in the Y axis window.

1. To enter calculator mode press the [**CALC**] key.
   The X axis shows '0'.
   The Y axis is blank (no display).
2. You can enter a number using the [0…9]. [**+/-**] and [**.**] keys. This number is shown on the X-axis. If you make a mistake, you can press the [**C**] key to delete the entered numbers one at a time. When you delete the last entered number ithe X axis shows '0'.
3. When you have entered the number, press the [**Y**] axis key.
   The Y axis legend shows 'Add'.
4. To select a different mathematical function press the [**Y**] axis key until the required option is displayed.

*When you press the [**Y**] key the result of the current calculation is displayed in the X-axis. Thus if no sum has yet been performed the current entered number is displayed.*

5. You can now enter the next number.
   Entering this number changes the X axis display.
6. You can now either press [**ENTER**] to complete your mathematical operation (See Example 1) or press the [**Y**] axis key again and keep the mathematical operations going (See Example 2).
7. If you press [**ENTER**], the X axis shows the calculation result and the Y axis is blank.

*You can press the [**CALC**] key at any time to exit the calculator function.*

Example 1

To perform the calculation 43.5 - 10.2 = 33.3:

1. Press the [**CALC**] key to enter the calculation function.
2. Press the keys [**4**] [**3**] [**.**] [**5**].
3. Press the [**Y**] axis key until ‘Sub’ appears on the display.
4. Press the keys [**1**] [**0**] [**.**] [**2**].
5. Press the [**ENTER**] key to complete the calculation.
   The result is shown in the X axis window.
6. Press the [**CALC**] key to exit the calculator function.

Once you have pressed the [**ENTER**] key and the calculation result is displayed you have several options available:

- Press the [**CALC**] key to exit calculator mode.
- Press the [**C**] key to clear the X axis display to '0' to start a new calculation as if calculator mode had just been entered.
- Enter a new number as the start of a new calculation. When you enter the number it automatically clears the existing calculation result and the new numbers appear in the X axis window. The Y axis window is blank.
- With the result displayed in the X axis window, you can press the Y axis key to select a mathematical function. Here the value in the X axis window from the previous calculation is used as the first number in the new calculation.

Example 2

To perform the calculation (43.5 - 10.2) x 9 = 299.7.

1. Press the [**CALC**] key to enter the calculation function.
2. Press the keys [**4**] [**3**] [**.**] [**5**].

3. Press the [**Y**] axis key until ‘Sub’ appears on the display.
4. Press the keys [**1**] [**0**] [**.**] [**2**].
5. Press the [**Y**] axis key.
   This completes the calculationa dn the result is shown in the X axis window.
6. Press the [**Y**] axis key until ‘Multi’ appears on the display.
7. Press the [**9**] key.
8. Press the [**ENTER**] key to complete the calculation.
   The result is shown in the X axis window.
9. Press the [**CALC**] key to exit the calculator function.

Special features

This chapter describes the M20's special features.

Selectable counting direction

This feature allows counting in either the left or right direction. See Setting the counting direction on page 2-3 for further details.

Floating negative sign

In cases where the current tool position is negative, the negative sign is shown by the first digit of the value. As the value increases the negative sign moves to the next digit. This feature improves the readability of the display as compared to having the negative sign at the last digit.

Non-volatile memory

This memory is used to store 20 SDM values, 4 tool offsets, the settings of the DRO and the machine reference values.

Near zero warning

This feature is to alert you when the tool is approaching the required position (towards zero).

Keyboard lock

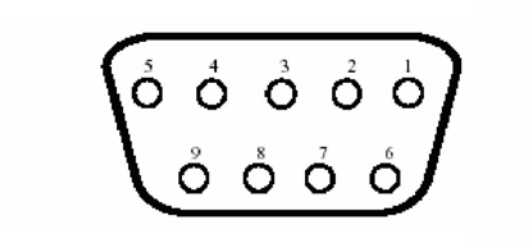
During machining, if you accidently reset any one of the axes, then the current work piece may be damage. To avoid this, you can use the keyboard lock facility. See Setting the keyboard lock on page 2-4 for further details.

Appendix 1: Other information

This appendix gives some further information that you may find useful when using the M20.

Pin connections

Pin connection details for 9-pin ‘D’ (F) type connector (DRO side) Axis x, y, viewed from rear.



Pin connections

Connector	Signal
	For line receiver TTL interface (optional)
1	Phase RM
2	$\overline{\text{Phase RM}}$
3	VCC (+5)
4	Shield
5	Gnd (0V)
6	Phase A
7	$\overline{\text{Phase A}}$
8	Phase B
9	$\overline{\text{Phase B}}$

Recommended spares

- Glass fuse slow blow as specified in DRO Specifications.
- Mains Cord.
- CPU PCB Assembly.
- Power supply Assembly with Back Plate.

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